Evaluating the stratigraphic response to large meteorite impacts

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The Manicouagan impact structure of east-central Quebec province, is one of the largest known impact craters on Earth, weighing in at about 100 km. Published ages from the melt sheet were not precise and ages from different minerals and whole rocks did not all overlap leaving open the possibility that the impact was the age of the Triassic-Jurassic (T-J) boundary. This boundary is one of five major mass extinction events that have been recognized in the Phanerozoic. Combined Ar-Ar feldspar and U-Pb zircon results from the upper melt sheet give ages of 214.8 +/- 2 Ma and 215.6 +/- 0.2 Ma respectively. More individual analyses of some of the larger feldspar grains will likely reduce the uncertainty in the Ar age. The difference between these systems is expected as Ar-Ar results are ubiquitously younger than U-Pb age results. The age of Manicouagan is distinctly older than the T-J boundary which is approximately 202 Ma. It is also distinctly younger than the most recent estimate of the Carnian-Norian boundary of the Late Triassic (227 Ma) and in fact, it does not coincide with any known biological perturbation. However, the Upper Triassic is very poorly dated. U-Pb zircon ages from the Middle Triassic of Italy are about 237 Ma and U-Pb zircon ages from the Central Atlantic Magmatic Province (CAMP) of 201 Ma bracket this boundary but there are no conventional ages within this interval. Age constraints are based on a detailed cyclo-stratigraphic and magnetostratigraphic record from the terrestrial Newark Supergroup and extrapolation of this magnetostratigraphy to the marine realm assuming the so-called McLaughlin cycles of the Newark Supergroup are 404 ky period. Precise ages from the Manicouagan melt sheet allow a test of the McLaughlin cycle durations. The melt sheet is normal polarity and the age requires that the ejecta should be found within the E14 interval if the Milankovitch interpretation is correct. This narrows the search to a 300 meter interval which is archived in cores as well as in outcrops. The sediments filling the Newark Basins are derived from local Paleozoic basement and have eNd of approximately -8 while our results indicate that the impact layer should have eNd of approximately -18. We expect the Pb isotopic signature will also be diagnostic as the crater is in Archean crust that was strongly overprinted in the ca. 1 Ga Grenvillian orogeny.